METHOD FOR PREPARATION OF DEUTERIUM BY ISOTOPE SEPARATION

The present invention relates to a process for the separation of deuterium and hydrogen.

For the manufacture of the technically very important heavy water, D_2O, essentially the following physically different methods are used:

In the Clusius separation column process, the effect of the thermo-diffusion and thermo-convection are utilized. Hydrogen as the lighter component thereby rises along a heated wire in the center of a glass column approximately 20 meters in length, whereas deuterium as heavier component of the gas mixture sinks down along the cool column wall. Consequently, the pure hydrogen is conducted away at the upper column end whereas pure deuterium is obtained at the lower end.

In order to achieve a higher efficiency of the separating column process, the latter is coupled with an ultracentrifuge. In a centrifuge running at very high rotational speed, the lighter isotope also concentrates in the center whereas the heavier isotope concentrates at the edge, whence the thermal-diffusion effect is assisted.

If one starts with liquid hydrogen in the deuterium recovery, then one obtains by fractionated distillation an enrichment or collection of hydrogen in the vapor and of deuterium in the liquid.

Also in chemical exchange reactions between liquid and vapor phase, nearly always a shift in the isotope ratio takes place. Thus, in the sulfur hydrogen method, the H_2S gas, conducted through hot water, absorbs deuterium in order to give off the same again to cold water during the exchange and to concentrate or enrich thereat.

According to the last-mentioned method, D_2O is manufactured in Canada, the country with the largest heavy water reactors. The planning of additional power reactors on the basis of heavy water has caused a bottleneck in the D_2O supply so that the requirements cannot be met. This shortage in D_2O and the manufacturing process itself lead to high prices for the heavy water.

It is the aim of the present invention to obtain both a less expensive method of manufacturing as also an increased production rate in deuterium and therewith in heavy water.

It has been discovered that the two alloys, namely Ti_2Ni and TiNi, are able to absorb in the lattice thereof, hydrogen in very large quantities but deuterium only very slightly or not at all at temperatures up to 350° C., especially at temperatures of about 50° to about 150° C.

If one uses specifically TiNi for such separating experiments, then exclusively hydrogen is absorbed in large quantities whereas the gas residue is enriched with deuterium above the TiNi inserted as powder or as solid body.

The alloys of Ti_2Ni and the alloy mixtures Ti_2Ni/TiNi also behave similarly.

Accordingly, it is an object of the present invention to provide a method for obtaining deuterium by isotope separation which avoids by simple means the aforementioned shortcomings and drawbacks encountered in the prior art.

Another object of the present invention resides in a method of obtaining deuterium by isotopic separation which entails a reduction in the cost of manufacture as well as a higher production rate due to improved efficiency.

Still a further object of the present invention resides in a process for obtaining deuterium by isotope separation at titanium-nickel phases, which is simple and relatively inexpensive, yet considerably increases the yield.

These and further objects, features and advantages of the present invention will become more apparent from the following description, setting forth a preferred embodiment of the present invention.

The aim of the present invention is, as mentioned above, a method for the separation of deuterium and hydrogen which essentially consists in that one causes the gaseous deuterium-containing hydrogen to come into contact with TiNi, Ti_2Ni or mixtures thereof and to separate the non-absorbed gaseous residue from the TiNi alloy and to isolate the gas enriched with deuterium or to conduct the same for further enrichment or concentrations. Metal additions of the group IIIb – VIIIb, as well as copper and traces of the rare earth metals are able to influence the behavior of the alloys. Thus, an addition of zirconium facilitates the hydrogen separation out of the phases whereas copper addition increases the mechanical rigidity. Depending on the desired type of application, such additives may therefore be preferred.

The isotope separating effect of the two alloys and of the alloy mixtures by reason of the hydrogen absorption in the alloy lattice may be used to advantage in two different ways for the manufacture of pure deuterium or for the deuterium enrichment.

One typical example of a method of operation according to the present invention essentially consists in bringing the hydrogen/deuterium mixture into contact with the respective alloys free of hydrogen by way of various stages. The deuterium content in the residual gas therefore increases constantly and the mixture strongly enriched with deuterium can be conducted again either in a continuous, closed cycle process over the dehydrogenated alloys, or can be separated according to known methods, known as such in the prior art.

Another possibility of the present invention essentially resides in filling a Clusius separating column with a powder of the aforementioned TiNi alloys and to utilize now in common the absorption effect and the thermal effect. The heating wire of the column is therefore surrounded by the powder and the hydrogen concentration drop along the column is clearly increased by the high hydrogen absorption of the alloys. Of course, for purposes of filling, for example, also sintered bodies or granulates of the alloys may be used, though a powder filling is most simple.

The waste product or by-product of the separating process, namely the more or less fully hydrogenated titanium/nickel alloys, may in their turn again find a large commercial use in the battery construction and as pressureless hydrogen storage means, or they are dehydrated so that the metal can be fed again to the renewed contact with the hydrogen/deuterium gas. The dehydrogenation may take place in a conventional known manner, for example, by heating possibly assisted by a vacuum.

Since the price per kilo of the TiNi alloys at present amounts to only DM 10 — and since the enrichment processes can take place very rapidly, the production costs can be decreased by means of the process according to the present invention, and the yearly production